UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/539,624	03/31/2000	Jerrie L. Coffman	219.38025X00	9576

7590   12/12/2005

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EXAMINER
ALI, SYED J

ART UNIT	PAPER NUMBER
2195	

DATE MAILED: 12/12/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE <u>3</u> MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on <u>22 September 2005</u>.

2a)☐ This action is **FINAL**.   2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) <u>1-21</u> is/are pending in the application.

   4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) <u>1-21</u> is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

   Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

   Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   a)☐ All   b)☐ Some * c)☐ None of:

      1.☐ Certified copies of the priority documents have been received.

      2.☐ Certified copies of the priority documents have been received in Application No. _____.

      3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

   * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1)☒ Notice of References Cited (PTO-892)

2)☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3)☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
   Paper No(s)/Mail Date _____.

4)☐ Interview Summary (PTO-413)
   Paper No(s)/Mail Date. _____.

5)☐ Notice of Informal Patent Application (PTO-152)

6)☐ Other: _____.

DETAILED ACTION

1.   This office action is in response to the amendment filed September 22, 2005. Claims 1-

21 are presented for examination.

2.   The text of those sections of Title 35, U.S. code not included in this office action can be

found in a prior office action.

Claim Rejections - 35 USC § 103

3.   **Claims 1-7, 9-10, and 20-21 are rejected under 35 U.S.C. 103(a) as being**

unpatentable over Clark (USPN 6,598,068) in view of Oliver (USPN 6,029,190).

4.   As per claim 1, Clark teaches the invention as claimed, including a system comprising:

a shared resource (col. 5 lines 21-22);

multiple threads arranged to access said shared resource (col. 5 lines 33-36; col. 9 lines

28-30); and

an operating system configured to allow said threads to perform work on said shared

resource while supporting state changes or updates of said shared resources (col. 4 lines 11-13),

said operating system comprising a synchronization algorithm for synchronizing multiple worker

threads of operation with a single thread so as to achieve mutual exclusion between multiple

worker threads performing work on said shared resource (col. 4 lines 13-18) and a single update

thread updating or changing the state of said shared resource (col. 9 line 66 - col. 10 line 4) such

that an update or change of the state of the shared resource may be made by the single update

thread only when none of the multiple worker threads are processing work on the shared resource (col. 9 lines 53-63).

5.   Oliver teaches the invention as claimed, including multiple worker threads performing work on a shared resource without serialization, wherein the multiple worker threads are able to perform work on the shared resource concurrently (col. 2 line 60 - col. 3 line 43).

6.   Clark generally provides a method of synchronizing access to a shared resource by multiple worker threads by way of a single main update thread. However, as correctly noted by Applicant, Clark still requires serial access to the resource, i.e. only one thread can access the resource at a time with the main thread intervening to regulate access to the resource (see page 3 of Applicant's arguments). The reason that Clark requires serial access is due to traditional limitations of mutual exclusion, in that while a thread holds a lock on a resource, all other threads are forced to wait for the lock to become available. Oliver sets out to solve exactly this type of problem by allowing multiple threads to access a resource concurrently, provided that the threads are all reading from the resource (writer threads require exclusive access due to potential data inconsistency issues; this is unavoidable if reliable data is desired). Rather than simply use a mutex to synchronize access to the resource, the lock mechanism is bifurcated by implementing two objects, a mutex and a semaphore. This allows a thread to lock a resource and release the synchronization objects for other threads to secure a concurrent lock. Referring to Figure 7 of Clark, the worker thread locks the resource, performs work, and releases the resource for other threads. By implementing the lock mechanism of Oliver, the worker thread would be able to lock the resource, release the synchronization objects for other threads to lock the resource, and *then* perform whatever work is needed. Thus, it would have been obvious to a

person having ordinary skill in the art to combine Clark and Oliver; a person having ordinary skill in the art would be motivated to make the combination since Clark and Oliver due to the nature of the problem to be solved, i.e. providing synchronized access to a shared resource in a multi-threaded environment (Clark, col. 5 lines 21-30; Oliver, col. 2 lines 2-7).

7.   It is noted that neither Clark nor Oliver specifically discusses the use of multiple processors. Nonetheless, multi-processor systems are prevalent in the art, particularly with multi-threaded and multi-processing algorithms. In fact, synchronization is a significant concern when dealing with multiple threads attempting to access the same resource; data integrity could be compromised if an efficient method of regulating the access to the resource is not provided. Thus, utilizing the synchronization algorithm provided by the combination of Clark and Oliver in a multiprocessor environment would have been obvious to a person having ordinary skill in the art.

8.   As per claim 2, Clark teaches the invention as claimed, including the system as claimed in claim 1, wherein said shared resource includes work queues associated with a hardware adapter configured to send and receive message data to/from a remote system (col. 8 lines 45-49; col. 10 lines 46-52).

9.   As per claim 3, Clark teaches the invention as claimed, including the system as claimed in claim 2, wherein said synchronization algorithm is executed to synchronize any update thread wishing to update or change a state of said shared resource with all the worker threads processing I/O operations on said shared resource (col. 9 line 66 - col. 10 line 4).

10.   As per claim 4, Clark teaches the invention as claimed, including the system as claimed
in claim 1, wherein said synchronization algorithm is executed to allow worker threads to work
concurrently while processing I/O operations in exclusion of an update thread when a state of
said shared resource is not changing, and allow an update thread to change the state or update
said shared resource in exclusion of multiple worker threads (col. 9 lines 41-43).

11.   As per claim 5, Clark teaches the invention as claimed, including the system as claimed
in claim 4, wherein said synchronization algorithm is executed to support a worker thread
operation for processing simultaneous I/O operations on said shared resource while concurrently
supporting an update thread operation for updating or changing the state of said shared resource
(col. 9 line 66 - col. 10 line 4).

12.   As per claim 6, Clark teaches the invention as claimed, including a system as claimed in
claim 5, wherein said worked thread operation is invoked by one of an event and a user's
request, and is performed by:

   determining whether a lock is available (col. 9 lines 51-53);

   if the lock is not available, waiting until the lock becomes available (col. 9 lines 59-61);

   if the lock is available, seizing the lock while incrementing a count by a discrete constant
to indicate the number of worker threads that are active, and then releasing the lock after the
count has been incremented (col. 9 lines 41-43);

after the lock has been released, allowing multiple worker threads to process work concurrently (col. 10 lines 55-61);

determining next whether there is work to be processed (col. 11 lines 11-21);

if there is work to be processed, processing the work until there is no work to be processed (col. 10 line 62 - col. 11 line 21); and

if there is no work to be processed, decrementing the count by a discrete constant to indicate when all the worker threads are done with completion processing (col. 10 lines 5-14).

13.   As per claim 7, Clark teaches the invention as claimed, including a system as claimed in claim 6, wherein said update thread operation is invoked by a user's request, and is performed by:

determining whether a lock is available (col. 9 lines 51-53);

if the lock is not available, waiting until the lock becomes available when released by any one of the worker threads (col. 9 lines 59-61);

if the lock is available, seizing the lock until the count becomes zero (0) to indicate that it is safe to update or change the state of said shared resource, and updating or changing the state of said shared resource (col. 9 line 51 - col. 10 line 4); and

after said shared resource has been updated, releasing the lock so as to allow either new worker threads to continue I/O operation processing or a different update thread to continue shared resource updating (col. 9 line 51 - col. 10 line 14).

14.   As per claim 9, Clark teaches the invention as claimed, including the system as claimed

in claim 2, wherein said synchronization algorithm is installed as part of a software driver

module of an operation system [OS] kernel or an user-level application of said system (Fig. 4).

15.   As per claim 10, Clark teaches the invention as claimed, including the system as claimed

in claim 2, wherein said shared resource includes one of work queues, completion queues, FIFO

queues, hardware adapters, I/O controllers and other memory elements of said system (col. 1

lines 17-24).

16.   As per claim 20, Clark teaches the invention as claimed, including a process of

synchronizing an update thread which updates a list of work queues with multiple worker threads

which operate on items in the list of work queues in a system, comprising:

allowing a group of worker threads to access the list of work queues to process I/O

operations in mutual exclusion, when states of the work queues are not changing (col. 4 lines 13-

18);

incrementing a count of threads processing I/O operations each time a worker thread is

running (col. 9 lines 41-43), while decrementing the count of threads processing I/O operations

each time a worker thread is done processing I/O operations (col. 10 lines 5-14);

when the count of threads reaches a designated value indicating that no worker threads

are running, allowing an update to access and update the list of work queues in exclusion of new

worker threads from processing I/O operations (col. 9 line 51 - col. 10 line 4); and

after the list of work queues is updated, allowing new worker threads to perform I/O

operations until all worker threads are done processing I/O operations (col. 9 line 51 - col. 10

line 14).

17.   Oliver teaches the invention as claimed, wherein the multiple worker threads are able to

perform work on the shared resource concurrently (col. 2 line 60 - col. 3 line 43).

18.   It is noted that neither Clark nor Oliver specifically discusses the use of multiple

processors. Please see paragraph 7 for further discussion of this matter.

19.   As per claim 21, Clark teaches the invention as claimed, including a computer readable

medium that stores computer executable instructions for implementing the process of claim 20

(Fig. 2).

**20.   Claims 8 and 11-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over
Clark in view of Oliver and further in view of Tillier (USPN 6,421,742).**

21.   As per claim 8, Tillier teaches the invention as claimed, including a system as claimed in

claim 2, further comprising data channels formed between said system and said remote system,

via a switched fabric, and supported by the *"Virtual Interface [VI] Architecture Specification"*

and the *"Next Generation Input/Output [NGIO] Specification"* for message data transfers

between said system and said remote system (col. 5 lines 14-36).

22.   It would have been obvious to one of ordinary skill in the art to combine the modified

Clark with Tillier since Clark discusses synchronization of threads using shared resources in a

computer system including a network (col. 8 lines 39-42), but does not address specific types of

networks, such as a switched fabric network. Tillier teaches a way of implementing such

systems and would allow Clark to be implemented on a wider variety of systems.

23.   As per claim 11, Clark teaches the invention as claimed, including a network,

comprising:

          a host system comprising including work queues each configured to send and receive

message data (col. 8 lines 45-49; col. 10 lines 46-52); and an operating system configured to

allow processors to perform work on said work queues while supporting state changes of said

work queues (col. 4 lines 11-13), said operating system comprising a synchronization algorithm

for synchronizing multiple worker threads of operation with a single update thread so as to

achieve mutual exclusion between multiple worker threads performing work on said work

queues (col. 4 lines 13-18) and a single update thread changing the state of said work queues

(col. 9 line 66 - col. 10 line 4) such that an update or change of the state of the work queues may

be made by the single update thread only when none of the multiple worker threads are

processing work on the work queues (col. 9 lines 53-63).

24.   Oliver teaches the invention as claimed, including multiple worker threads performing

work on a shared resource without serialization, wherein the multiple worker threads are able to

perform work on the shared resource concurrently (col. 2 line 60 - col. 3 line 43).

25.   Tillier teaches the invention as claimed, including:

          a switched fabric (col. 5 lines 14-36);

          remote systems attached to said switched fabric (col. 2 lines 20-40); and

a host system comprising multiple processors; a host-fabric adapter provided to interface with said switched fabric and including work queues each configured to send and receive message data from a single remote system, via said switched fabric (Fig. 1).

26.   As per claims 12-19, Clark teaches the invention as claimed, including the system of claims 3-9. That is, the limitations presented in claims 12-19 are essentially the same as those presented in claims 3-9. Therefore, the discussion of claims 3-9 form the basis for rejection of the present claims as well.

Response to Arguments

27.   **Applicant's arguments with respect to claims 1-21 have been considered but are moot in view of the new grounds of rejection.**

Conclusion

28.   Any inquiry concerning this communication or earlier communications from the examiner should be directed to Syed J. Ali whose telephone number is (571) 272-3769. The examiner can normally be reached on Mon-Fri 8-5:30, 2nd Friday off.
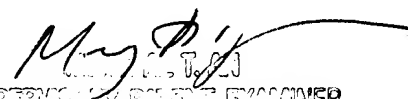
If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Meng-Ai T. An can be reached on (571) 272-3756. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent

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system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR

system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Syed Ali
November 30, 2005

SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2100